

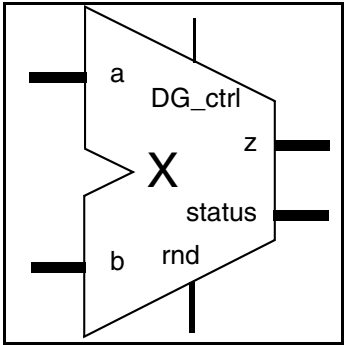
# DW\_fp\_mult\_DG

## Floating-Point Multiplier with Datapath Gating

Version, STAR, and myDesignWare Subscriptions: [IP Directory](#)

### Features and Benefits

- Has the same functionality as DW\_fp\_mult when the component is in normal operation
- Consumes less dynamic power than DW\_fp\_mult when disabled (inputs are active, but the output is not being used)
- The precision format is parameterizable for either IEEE single, double precision, or a user-defined custom format
- Hardware for denormal numbers of IEEE 754 standard is selectively provided.
- Configurable to be fully compliant with the IEEE Std 754-1985 standard
- Configurable for NaN representation compatible with the IEEE Std 754-2008 standard (controlled by the *ieee\_compliance* parameter)
- DesignWare datapath generators are employed for better power and QoR



### Revision History

### Description

DW\_fp\_mult\_DG is a floating-point multiplier that multiplies two floating-point values, a and b, to produce a floating-point sum, z. Also, a control input (DG\_ctrl) can disable the component to reduce dynamic power consumption when the component is not in use and inputs are still active.

Component pins are described in [Table 1-1](#) and configuration parameters are described in [Table 1-2](#).

**Table 1-1 Pin Description**

Pin Name	Width	Direction	Function
a	(sig_width + exp_width + 1) bits	Input	Multiplier
b	(sig_width + exp_width + 1) bits	Input	Multiplicand
rnd	3 bits	Input	Rounding mode; supports all rounding modes described in the <a href="#">Datapath Floating-Point Overview</a>
z	(sig_width + exp_width + 1) bits	Output	Product of a X b

**Table 1-1 Pin Description (Continued)**

Pin Name	Width	Direction	Function
status	8 bits	Output	<ul style="list-style-type: none"> <li>Status flags corresponding to <i>z</i>; for details, see <a href="#">STATUS Flags</a> in the <i>Datapath Floating-Point Overview</i></li> <li>status[6]: Underflow before rounding (UBR) status flag When enabled by the <i>en_ubr_flag</i> parameter, this flag indicates when the absolute value of a non-zero result, computed as though both the exponent range and the precision of the significand were unbounded, would lie strictly between <math>\pm\text{MinNorm}</math> (minimum normalized value representable in the FP format defined by <i>sig_width</i> and <i>exp_width</i>).</li> </ul>
DG_ctrl	1 bit	Input	Datapath gating control <ul style="list-style-type: none"> <li>0 = Component is disabled</li> <li>1 = Normal component operation</li> </ul> See “ <a href="#">Datapath Gating Control with DG_ctrl</a> ” on page 3.

**Table 1-2 Parameter Description**

Parameter	Values	Description
sig_width	2 to 253 bits	Word length of fraction field of floating-point numbers <i>a</i> , <i>b</i> , and <i>z</i>
exp_width	3 to 31 bits	Word length of biased exponent of floating-point numbers <i>a</i> , <i>b</i> , and <i>z</i>
ieee_compliance	0, 1, or 3 Default: 0	Level of support for the IEEE Std 754 standards: <ul style="list-style-type: none"> <li>0: No support for NaNs and denormals; NaNs are considered infinities and denormals are considered zeros</li> <li>1: Fully compliant with the IEEE Std 754-1985 standard, including support for NaNs and denormals</li> <li>2: Reserved</li> <li>3: Fully compliant with the IEEE Std 754-1985 standard plus NaN representation that matches the IEEE Std 754-2008 standard<sup>a</sup></li> </ul> For details, see <a href="#">Compatibility with IEEE Std 754 Standards</a> in the <i>Datapath Floating-Point Overview</i>
en_ubr_flag	0 or 1 Default: 0	Controls when the underflow before rounding (UBR) flag in <i>status</i> [6] is enabled <ul style="list-style-type: none"> <li>0: The UBR status flag is disabled (the flag is always 0)</li> <li>1: The UBR status flag is enabled</li> </ul>

a. Propagating payload information to the output during the NaN process, which is an optional feature specified in the IEEE Std 754-2008 standard, is not supported.

**Table 1-3 Synthesis Implementations**

Implementation Name	Function	License Feature Required
rtl	Datapath gating close to the main inputs	<ul style="list-style-type: none"> <li>■ DesignWare (P-2019.03 and later)</li> <li>■ DesignWare-LP (before P-2019.03)</li> </ul>
rtl2 <sup>a</sup>	Datapath gating in the middle of the component	<ul style="list-style-type: none"> <li>■ DesignWare (P-2019.03 and later)</li> <li>■ DesignWare-LP (before P-2019.03)</li> </ul>

a. By default, the rtl2 implementation is used for synthesis (for more, see [“Datapath Gating Control with DG\\_ctrl”](#) on page 3).

**Table 1-4 Simulation Models**

Model	Function
DW02.DW_FP_MULT_DG_CFG_SIM	Design unit name for VHDL simulation
dw/dw02/src/DW_fp_mult_DG_sim.vhd	VHDL simulation model source code
dw/sim_ver/DW_fp_mult_DG.v	Verilog simulation model source code

DW\_fp\_mult\_DG provides the hardware for denormal numbers and NaNs of IEEE 754 standard. If the parameter `ieee_compliance` is turned off, denormal numbers are considered as zeros, and NaNs are considered as Infinity. Otherwise, denormal numbers and NaNs become effective and additional hardware for the multiplication of denormal numbers is integrated.

## Datapath Gating Control with DG\_ctrl

For DW\_fp\_mult\_DG and other combinational components that have the datapath gating feature, the `DG_ctrl` port is provided to control datapath gating.

When `DG_ctrl = 1`, the component behaves as expected according to activity on the input ports.

When `DG_ctrl = 0`:

- The component is disabled and internal gates are totally or partially isolated to block propagation of switching activity inside the component. This makes the component less sensitive to switching activity on the main ports and reduces dynamic power consumption.
- Values at the output ports are not defined.
- Simulation models set 'X' values at the output ports.

The implementations for DW\_fp\_mult\_DG (see [Table 1-3](#) on page 3) perform datapath gating differently:

- The rtl implementation places datapath gating as close as possible to the input ports to maximize dynamic power savings when DG\_ctrl = 0. However, if the DG\_ctrl signal arrives later than the data inputs, timing is degraded and area is increased to recover timing, which can increase power.
- The rtl2 implementation places datapath gating near the middle of the component. This approach is less sensitive to the arrival time of DG\_ctrl and has a better chance of meeting timing and still providing dynamic power savings.

By default, the synthesis tool uses the rtl2 implementation, but you can override that. If timing constraints are loose or you know that the signal driving the DG\_ctrl port arrives at the same time as other input signals, greater power savings can be attained by using the rtl implementation. You can make the override on a global level or on a case-by-case basis, as explained next.

To use the rtl implementation globally, you can disable the rtl2 implementation as follows:

- Design Compiler (before version P-2019.03):  

```
set_dont_use {dw_minpower.sldb/DW_fp_div_DG/rtl2}
```
- Design Compiler (P-2019.03 and later)  

```
set_dont_use {dw_foundation.sldb/DW_fp_div_DG/rtl2}
```
- Fusion Compiler:  

```
set_synlib_dont_use {dw_foundation/DW_fp_div_DG/rtl2}
```

To use the rtl implementation for specific instantiated components, use the set\_implementation command:

```
set_implementation U1 rtl
```

## Suppressing Warning Messages During Verilog Simulation

The Verilog simulation model includes macros that allow you to suppress warning messages during simulation.

To suppress all warning messages for all DWBB components, define the DW\_SUPPRESS\_WARN macro in either of the following ways:

- Specify the Verilog preprocessing macro in Verilog code:  

```
`define DW_SUPPRESS_WARN
```
- Or, include a command line option to the simulator, such as:  

```
+define+DW_SUPPRESS_WARN
```

 (which is used for the Synopsys VCS simulator)

The warning messages for this model include the following:

- If an invalid rounding mode has been detected on rnd, the following message is displayed:

```
WARNING: <instance_path>:  
at time = <timestamp>: Illegal rounding mode.
```

To suppress this message, use the DW\_SUPPRESS\_WARN macro explained earlier.

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## Related Topics

- [Datapath Floating-Point Overview](#)
- [DesignWare Building Blocks User Guide](#)

## HDL Usage Through Component Instantiation - VHDL

```
library IEEE,DWARE;
use IEEE.std_logic_1164.all;
use DWARE.DWpackages.all;
use DWARE.DW_Foundation_comp.all;

entity DW_fp_mult_DG_inst is
  generic (
    inst_sig_width : POSITIVE := 23;
    inst_exp_width : POSITIVE := 8;
    inst_ieee_compliance : INTEGER := 1;
    inst_en_ubr_flag      : INTEGER := 0
  );
  port (
    inst_a : in std_logic_vector(inst_sig_width+inst_exp_width downto 0);
    inst_b : in std_logic_vector(inst_sig_width+inst_exp_width downto 0);
    inst_rnd : in std_logic_vector(2 downto 0);
    inst_DG_ctrl : in std_logic;
    z_inst : out std_logic_vector(inst_sig_width+inst_exp_width downto 0);
    status_inst : out std_logic_vector(7 downto 0)
  );
end DW_fp_mult_DG_inst;

architecture inst of DW_fp_mult_DG_inst is

begin

  -- Instance of DW_fp_mult_DG
  U1 : DW_fp_mult_DG
    generic map ( sig_width => inst_sig_width, exp_width => inst_exp_width,
    ieee_compliance => inst_ieee_compliance, en_ubr_flag => inst_en_ubr_flag )
    port map ( a => inst_a, b => inst_b, rnd => inst_rnd, DG_ctrl => inst_DG_ctrl, z =>
    z_inst, status => status_inst );

end inst;

-- pragma translate_off
configuration DW_fp_mult_DG_inst_cfg_inst of DW_fp_mult_DG_inst is
  for inst
  end for; -- inst
end DW_fp_mult_DG_inst_cfg_inst;
-- pragma translate_on
```

## HDL Usage Through Component Instantiation - Verilog

```
module DW_fp_mult_DG_inst( inst_a, inst_b, inst_rnd, inst_DG_ctrl, z_inst,
                           status_inst );

    parameter sig_width = 23;
    parameter exp_width = 8;
    parameter ieee_compliance = 1;
    parameter en_ubr_flag = 0;

    input [sig_width+exp_width : 0] inst_a;
    input [sig_width+exp_width : 0] inst_b;
    input [2 : 0] inst_rnd;
    input inst_DG_ctrl;
    output [sig_width+exp_width : 0] z_inst;
    output [7 : 0] status_inst;

    // Instance of DW_fp_mult_DG
    DW_fp_mult_DG #(sig_width, exp_width, ieee_compliance, en_ubr_flag)
        U1 ( .a(inst_a), .b(inst_b), .rnd(inst_rnd), .DG_ctrl(inst_DG_ctrl), .z(z_inst),
            .status(status_inst) );

endmodule
```

## Revision History

For notes about this release, see the [DesignWare Building Block IP Release Notes](#).

For lists of both known and fixed issues for this component, refer to the [STAR report](#).

For a version of this datasheet with visible change bars, click [here](#).

Date	Release	Updates
June 2022	DWBB_202203.2	<ul style="list-style-type: none"> <li>Added the description of <code>status[6]</code> to <a href="#">Table 1-1</a> on page <a href="#">1</a></li> <li>Added the <code>en_ubr_flag</code> parameter to <a href="#">Table 1-2</a> on page <a href="#">2</a> and to the examples on <a href="#">page 6</a> and <a href="#">page 7</a></li> </ul>
October 2020	DWBB_202009.1	<ul style="list-style-type: none"> <li>For enhanced NaN compatibility with the IEEE Std 754 standards, added a new value for <code>ieee_compliance</code> in <a href="#">Table 1-2</a> on page <a href="#">2</a></li> </ul>
July 2020	DWBB_201912.5	<ul style="list-style-type: none"> <li>Adjusted the description of the <code>ieee_compliance</code> parameter in <a href="#">Table 1-2</a> on page <a href="#">2</a></li> <li>Added <a href="#">“Suppressing Warning Messages During Verilog Simulation”</a> on page <a href="#">4</a></li> </ul>
March 2019	DWBB_201903.0	<ul style="list-style-type: none"> <li>Added <a href="#">“Datapath Gating Control with DG_ctrl”</a> on page <a href="#">3</a></li> <li>Clarified some information about minPower</li> <li>Added this Revision History table and the document links on this page</li> </ul>



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